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SOFTWARE PRODUCT

GEOINFORMATION SYSTEM «PANORAMA»
(GIS Panorama)

The vector format is SXF. The structure of data is in binary form

PARB.00046-04 99 02

39 pages

2017

ANNOTATION

The open format of the digital information about district is intended for application in geoinformation systems for storage of the digital information about district, for data exchange between various systems, creations of digital and electronic maps, and solution of applied tasks.

The format was developed by specialists of Russian Military Topographic Service in 1992, and it was approved as the basic exchange format of the digital information about terrain in the Armed Forces and several Federal agencies of the Russian Federation in 1993.

The format is focused on storing information in the form of separate records with variable length for each territory object.

The format has a simple structure and a unique sequence of fields in the record that does not depend on the value of the information.

The format provides the ability to audit the integrity of data during storage and after transmission through communication lines, as well as minimal data loss when data errors occur – from one metric point to one object record for each erroneous data byte.

The format has a minimum data redundancy and stores the metric data in a binary form that ensures minimum file sizes.

Semantic data can be represented in binary, or in symbolic form.

The following changes were made to edition 4.0 (1999):

- field values Rectangular coordinates of the sheet angles are given in meters (previously – decimeters) with a floating point (previously – integers);
- field values Geodesic coordinates of sheet angles are given with a floating point in radians (previously – integers multiplied by 100,000,000);
- field values Reference data for the source material is given with a floating point in radians and meters (previously integers multiplied by 100,000,000 in radians and decimeters for the corresponding values);
- field values Reference data on the projection of the source material is given with a floating point in radians (previously – integers multiplied by 100,000,000);
- alignment of lengths and locations for fields of the passport and the descriptor data, it is a multiple of 4 or 8 bytes to simplify the data processing;
- the text fields of the passport and the data descriptor are presented in ANSI encoding, and terminated with a binary zero (previously in ASCIIZ encoding);
- it was added the flag of encoding title (earlier all the texts of the titles were presented in ASCIIZ encoding, now it can be encoded in ANSI).

The following changes were made to edition 4.0 (2004):

- it was added the field The attribute of spline construction by metric in the header structure of the data record due to the backup field;
- added Fields Offset to the North and Offset to the East in the structure of data passport record due to the reserve fields;
- the Group description field in the header structure of the data record is replaced by the Number of points for large objects field – for recording objects with the number of metric points greater than 65535.

The following changes were made to edition 4.0 (2006):

- the field of the Coordinate precision flag, in the passport record structure, is added due to the backup field – to save the number of significant digits in the object metric.

The following changes were made to edition 4.0 (2008):

- added the field Presence of the binding vector in the header structure of the data record due to the backup field. In the description of the object, it was added the record of vector binding for 3D object model (between the metric and semantics);

- added the field Attribute of text in UNICODE, in the header structure of the data record due to the backup field;
- added the field Attribute of special data sorting in the header structure of the data record due to the backup field.

The following changes were made to edition 4.0 (2012):
- added semantics of arbitrary length (Table 10).

The following changes were made to edition 4.0 (2014):
- fields are added The attribute of displaying the object above or below all in the header structure of the data record due to the backup field.

The following changes were made to edition 4.0 (2015):
- added the field Attribute of compression for graphics in the header structure of the data record due to the backup field.

The following changes were made to edition 4.0 (2015):
- added the field Multipolygon in the header structure of the data record due to the backup field.

The following changes were made to edition 4.0 (2017):
- added the field Flag of automatic maintenance for GUID objects in the data descriptor structure due to the backup field.

Changes are introduced to improve the accuracy and completeness of data presentation in SXF format.

At a reprint of the text the reference to a source is obligatory.

CONTENTS

1 GENERAL INFORMATION

The open format for exchange and storage of digital topographic, special and navigation maps, and city plans is designed for more effectively solution the following tasks:

- maintaining the archive of digital topographic, special and navigation maps and city plans;
- to increase the storage reliability and the reliability for the transmission of digital maps on various media and communication channels;
- to reduce the volume of stored information;
- to use various technologies and technical means for creating digital topographic and navigation maps and city plans, casting the result to a single format.

The open format has the following properties:

- all data is contained in a single file, which eliminates the possibility of archival or delivery to consumer information, in part, facilitated the search and the account of file; sample data from a file can be executed by a single sequential read of the file, which accelerates the process of copying control of the data structure, conversion and other, which are the main storage and exchange;
- all information about an individual object is stored in a separate record; there are no address references between parts of the file or different files, which ensures correct processing of data after software or hardware failures; If there is a failure while reading or recording data in SXF format, resulting in the loss of a file fragment, the records, located before and after the failed part, will be processed correctly;
- the structure of format SXF contains service fields (start record identifiers, identifier of file start, data descriptor, flags of semantics, record length fields, etc.), which are necessary to control the structural integrity of SXF files, data recovery after software and hardware failures, carrying out data revision during long-term storage in the archive;
- SXF format allows you to store metric objects in three-dimensional coordinate system in the integer kind or with a floating point, which allows you to build maps of high accuracy and solutions of other tasks;
- SXF format provides the recording of digital vector maps in the form of a text file, which facilitates the transfer of data between different hardware and software platforms and it accelerates the development of new converters;
- the format provides storage of space-logical connections of various kinds in the semantics of objects (using up to five characters for the characteristics codes), in the metric of objects (for storing sub-objects), in the header of the record (for references to titles and descriptions of logical groups for dissimilar objects);
- the composition of the passport data can be extended to account for the development of information provision through the application of key form for representation of the characteristics in the recording sheet frame; passport data, in the text version of the format, have a key form of presentation;
- the format does not include a description of the visual representation of digital map objects and city plans, which can be different even on the same computer model, but having different display tools, but the format allows you to organize the communication of data about the object and its presentation forms through classifier tables.

The conditional format code is SXF (Storage and eXchange Format – format of storage and exchange).

2 THE STRUCTURE OF THE FORMAT

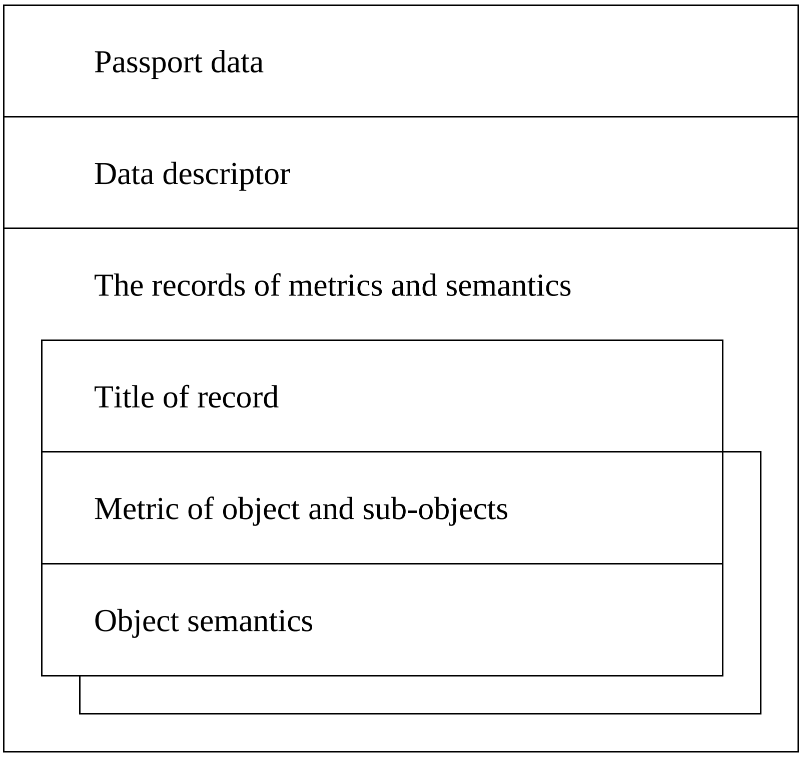
2.1 The structure of the format in binary form of representation

All digital information is placed in one file:

XXXXXXXX.SXF,

where XXXXXXXX – is the identifier of digital information for a given area, can be assigned by any rules.

Data in SXF format has the following structure:



All records are placed in one file, metric data and semantics for one object are located in one record – semantics (object characteristics) behind the metric (object coordinates).

2.1.1 The structure of the passport

The passport record contains metadata. The structure of metadata includes information that on paper maps is contained in behind frame design, and information, necessary to control the structural and logical integrity of digital data.

The data in the passport record is stored in symbolic and binary form, depending on the recording field.

The character fields are filled in ANSI format. Binary fields contain integers in 4 bytes. If the data for some fields are unknown, then the field must contain a number – minus one (0xFFFF or 0xFFFFFFFF).

Fields of 8 bytes long in the format with floating-point of the standart IEEE, if there are no data, the fields contain a zero value.

Table 1 - The structure of SXF Passport

Field assignment	Offset	Length	Comment
The identifier of file	+ 0	4	0x00465853 (SXF)

Field assignment	Offset	Length	Comment
The length of the passport record	+ 4	4	In bytes = 400 (in version 3.0 – 256)
Editorial format	+ 8	4	0x00040000 (in version 3.0 – 2 bytes, 0x0300)
Check sum	+ 12	4	For the entire file
The creation date of the dataset	+ 16	12	YYYYMMDD\0 (in version 3.0 – 10 bytes)
Nomenclature of the sheet	+ 28	32	ANSI (in version 3.0 – 24 bytes, ASCII)
Scale of the sheet	+ 60	4	Denominator of the scale
The code name of the sheet	+ 64	32	ANSI (in version 3.0 – 26 bytes, ASCII)
Information flags – The flag of data state – Reserve – The flag for presence of real coordinates – The flag of coding method – The table of generalization – The flag of the title coding – The flag of coordinate precision – The attribute of a special data sorting – Reserve	+ 96	4 2 bits 1 bit 2 bits 2 bits 1 bit 1 1 1 bit 7 bits	 Note 1. = 0 Note 2. Note 3. Note 4. Note 5. Note 6. 1 – the data is arranged in a special way = 0
The code EPSG for the system coordinate or 0	+100	4	The code EPSG (in version 3.0 – 12 bytes, reserve)
Rectangular coordinates for corners of the sheet: – X of the South-West corner – Y of the South-West corner – X of the North-West corner – Y of the North-West corner – X of the North-East corner – Y of the North-East corner – X of the South-East corner – Y of the South-East corner	+ 104	64 8 8 8 8 8 8 8 8	(in version 3.0 – 32 bytes) In meters X vertically Y horizontally (in version 3.0 – integers of 4 bytes, in decimeters)

Field assignment	Offset	Length	Comment
Geodetic coordinates for corners of the sheet: – B of the South-West corner – L of the South-West corner – B of the North-West corner – L of the North-West corner – B of the North-East corner – L of the North-East corner – B of the South-East corner – L of the South-East corner	+ 168	64 8 8 8 8 8 8 8 8	(in version 3.0 – 32 bytes) In radians (in version 3.0 – integers of 4 bytes, radians multiplied by 100 000 000)
Mathematical basis of the sheet: – Kind of ellipsoid – Heights system – Map projection – Coordinate system – The unit of measure in plan – The unit of measure for height – Frame type – The generalized map type	+ 232	8 1 1 1 1 1 1 1 1	 Note 7. Note 8. Note 9. Note 10. Note 11. 0 – meters Note 12. Note 13.
Reference data on the source material: – Date of survey or updating the map – Kind of the source material – Type of the source material – Zone identifier MSK-63 – The attribute of map limitation by the frame – Magnetic declination – The average convergence meridians – Annual change in magnetic declination – Date of the declination measurement – Zone number MSK-63 – Height of the relief section	+ 240	64 12 1 1 1 1 8 8 8 12 4 8	(in version 3.0 – 46 bytes) YYYYMMDD\0 (in version 3.0 – 10 bytes) Note 14. Note 15. A-X or 0 1 – map is limited by the frame In radians (in version 3.0 – integers of 4 bytes, radians multiplied by 100 000 000) YYYYMMDD\0 (in version 3.0 – 10 bytes) In meters (in version 3.0 – integer of 4 bytes, decimeters)
The angle of the axes rotation for the local coordinate systems	+ 304	8	In radians clockwise (in version 3.0 – 0 bytes)

Field assignment	Offset	Length	Comment
Resolution of the device	+ 312	4	Points per meter (integer). If the value is greater than zero, it is usually 20 000. If the Flag for presence of real coordinates (note 2) is not equal to zero – it is ignored.
Location of the frame on the device:	+ 316	32	(in version 3.0 – 16 bytes)
– X of the South-West corner		4	In discretes (points)
– Y of the South-West corner		4	
– X of the North-West corner		4	(in the system of the device)
– Y of the North-West corner		4	
– X of the North-East corner		4	X vertically
– Y of the North-East corner		4	Y horizontally
– X of the South-East corner		4	(in version 3.0 – integers of 2
– Y of the South-East corner		4	bytes)
Classification code for the frame of the map sheet	+ 348	4	From the classifier of objects
Reference data about the projection of the source material:	+ 352	48	(in version 3.0 – 20 bytes)
– The first main parallel		8	In radians
– The second main parallel		8	(in version 3.0 – integers of 4
– Axial meridian		8	bytes, radians multiplied by
– Parallel of the main point		8	100 000 000)
– Offset to the north		8	In radians (note 16)
– Offset to the east		8	(in version 3.0 – 4 bytes, reserve)
TOTAL:	400 bytes	(in version	3.0 – 256 bytes)

The coordinates of the metric points can be specified relative to the reference point, which does not coincide with the lower-left corner of the original material. This can be determined from X and Y coordinates of the South-West corner (in this case they are greater than zero). When digitized, the source material can be located in the coordinate system of the device with a rotation relative to the true position of the corresponding projection.

To rotate objects to the true position and take into account the deformation of the source material, there are taken into account the coordinates of the location for the frame on the device and the rectangular or geodetic coordinates for corners of the sheet.

If the frame of the sheet has more than 4 points – there are the coordinates of the corners for the frame stored in the passport sheet, and a full description of the metric is stored as a separate record in the data. At the same classification code that is recorded in the record header to the sheet frame should match the field value of **The classification code for the frame of the map sheet for record of the sheet passport.**

If it is necessary to expand the composition of passport data (for example, when developing a converter for a new type of format), codes are introduced into the classifier of semantic information to indicate new characteristics (up to 65535 in total) that must have a specific purpose and format for presentation. The service semantic characteristics are used to record **Datum** parameters and the user **ellipsoid**. These characteristics can be assigned to the sheet frame or service object, recorded to SXF file the first. For details, see Appendix 1.

Thus, the passport data can be transferred from the positional form of the representation to the key form, when the field assignment is determined by the preceding code. Thus the standard passport can't be filled at all, and all information will be selected from the record of semantics according to the specified scheme. This approach ensures the storage of arbitrary passport data (for example, geo-physical terrain data or additional data on the projection of the source material).

The procedure for calculating the checksum of the file is given in Appendix 2.

Notes:

1) The flag of data state (2 bits):

xxxxxx11 data in State 3 (format of data exchange)

2) The flag for presence of real coordinates (2 bits):

xxx00xxx the entire metric of the objects is represented in the conditional coordinate system (in discretes)

xxx11xxx the entire metric of objects is represented in real coordinates on the terrain in accordance with the sheet's passport data (projection, coordinate system, unit of measure), data on the scale and discreteness of the digitization have a reference character

3) The flag of coding method (2 bits):

x00xxxxx classification codes of objects and semantic characteristics are represented by decimal numbers recorded in binary form (for example: code of the object «32100000» is recorded in the form 0x01E9CEA0, the semantics code «253» is in the form 0x00FD)

4) The flag of generalization (1 bit):

0xxxxxxx the level of generalization is specified by the table of small-scale maps (described in Table 4)

1xxxxxxx the level of generalization is specified by the table of large-scale maps (described in Table 5)

5) The flag of the title coding for objects (1 byte):

0 encoded ASCIIZ (Dos)
1 encoded ANSI (Windows)
2 encoded KOI-8 (Unix)

6) The flag of coordinate precision (1 byte):

0 undefined
1 increased accuracy of coordinates storage (meters, radians or degrees)
2 coordinates are recorded with a centimeter precision (metres, 2 decimal places)
3 coordinates are recorded with a millimeter precision (meters, 3 decimals places)

7) Kind of ellipsoid (1 byte):

Value	Ellipsoid	Major semiaxis (m)	Polar compression
0	undefined		
1	Krasovsky of 1942	6378245	298.3
2	International of 1972 (WGS-72)	6378135	298.26
3	Heisford of 1909	6378388	297.0

Value	Ellipsoid	Major semiaxis (m)	Polar compression
4	Clark of 1880	6378249	293.5
5	Clark of 1866	6378206	295.0
6	Everest of 1857	6377276	300.0
7	Bessel of 1841	6377397	299.2
8	Airy of 1830	6377491	299.3
9	International of 1984 (WGS – 84)	6378137	298.257
10	The Earth parameters 90.02 (SGS-85)	6378136	298.257839
11	GRS-80	6378137	298.257222101
12	IERS of 1996	6378136.49	298.25645
13	International of 1924	6378388	297.0
14	South American of 1969	6378160	298.25
15	Indonesian of 1974	6378160	298.247
16	Helmert of 1906	6378200	298.3
17	Fisher of 1960, modified	6378155	298.3
18	Fisher of 1968	6378150	298.3
19	Hafa of 1960	6378270	297.0
20	Everest of 1830	6377276.345	300.8017
21	Australian National	6378160	298.25
22	CGCS2000	6378137	298.2572221
23	Airy modified	6377340.189	299.3249646
24	Bessel modified	6377492.018	299.1528128
25	Bessel Namibia	6377483.865	299.1528128
26	Bessel Namibia (GLM)	6377397.155	299.1528128
27	Clark of 1880 (Arc)	6378249.145	293.4663077
28	Clark of 1880 (SGA 1922)	6378249.2	293.46598
29	Everest of 1830 (1967 Definition)	6377298.556	300.8017
30	Everest of 1830, modified	6377304.063	300.8017
31	Everest of 1830 (RSO 1969)	6377295.664	300.8017
32	Everest of 1830 (1975 Definition)	6377299.151	300.8017255
33	NWL 9D	6378145	298.25
34	Plessis of 1817	6376523	308.64
35	Struve of 1860	6378298.3	294.73
36	War Office	6378300	296
37	GEM 10C	6378137	298.2572236
38	OSU86F	6378136.2	298.2572236
39	OSU91A	6378136.3	298.2572236
40	GRS 1967	6378160	298.2471674
41	Average Terrestrial System 1977	6378135	298.257
42	IAG 1975	6378140	298.257
43	GRS 1967, modified	6378160	298.25
44	Danish of 1876	6377019.27	300
45	Sphere on WGS 84	6378137	0
46	Geodetic Coordinate System-2011	6378136.5	298.2564151
47	PZ- 90.11	6378136	298.2578393
254	Arbitrary ellipsoid (see Appendix 1, codes 32880 and 32881)		

The above classification of reference data is not complete, and may be supplemented in the future.

8) Heights system (1 byte):

0 or 255 undefined
1 Baltic height system (based on Kronstadt graduated pole)
2 Australian height system 1971 year
3 Mean level of Adriatic Sea in Trieste (Austria)
4 Mean level of North Sea in Ostend 'Zero-Normal'
5 Mean low-water level of North Sea in Ostend (Belgium)
6 Mean sea level in a English Channel(Great Britain)
7 Mean level of Irish Sea in Belfast (Northern Ireland)
8 Mean level of Atlantic Ocean in Malik-Xed (Ireland)
9 Low water level in Dublin (Ireland)
10 Mean level of Aegean Sea at port of Piraeus (Greece)
11 Mean sea level near Danish coast (Denmark)
12 Mean level of Faxafloi Bay in Reykjavik (Iceland)
13 Mean level of Mediterranean Sea in Alicante (Spain)
14 Mean level of Atlantic Ocean (Canary Islands)
15 Mean level of Ligurian Sea in Genoa (Italy)
16 Mean level of Northern Sea (Netherlands, Germany)
17 Mean sea level in Oslo – 'Norwegian normal null' (South Norway)
18 Mean sea level in harbour of Narvik (Norway)
19 Mean level of Atlantic Ocean in Cascais (Portugal)
20 Mean level of Baltic Sea in Helsinki (Finland)
21 Mean water level in Swedish shores (Sweden)
22 Mean level of the Mediterranean Sea in Topsail (Francium, Switzerland)
23 Mean level of the seas surrounding Turkey (Turkey)
24 Mean level of the seas and oceans around USA and Canada (USA, Canada)
25 Baltic's system 1977 year
26 Mean level of Okhotsk sea and Pacific Ocean
27 Mean sea level (MSL)
28 Geodetic height on spheroid WGS-84
29 Geodetic height at a given spheroid
30 Height system of Con Dao (Vietnam)

The above classification of reference data is not complete, and may be supplemented in the future.

9) Projection of the source material (1 byte):

0 or 255 undefined
1 Conformal Gauss-Kruger
2 Conformal conic (code is outdated, apply 22)
3 Cylindrical special for space navigation maps of a scale of 40 000 000 (code is outdated)
4 Lambert azimuthal transverse equal-area (code is outdated, apply 30)
5 Azimuthal orthomorphic (stereographic) projection
6 Azimuthal equidistant(Postel)
7 Azimuth oblique equidistant (code obsolete, apply 30)
8 Cylindrical conformal (Mercator) (code is outdated, apply 36)
9 Cylindrical arbitrary (Urmaev) (code is outdated, apply 25)
10 Polyconic projection CNIIGAIK (code is outdated, apply 29)
11 Modified policonic (code is outdated, apply 29)
12 Pseudoconic arbitrary projection
13 Stereographic polar
14 Chebyshev conformal projection
15 Gnomonic (origin point 60,80 degrees)

16	Cylindrical special for scheme
17	Universal Transverse Mercator(UTM)
18	Kavrajsky pseudocylindrical sinusoidal equal-area projection
19	Mollweide pseudocylindrical elliptical equal-area projection
20	Conical equidistant (straight) projection
21	Authalic conical (straight) projection
22	Conformal conical (straight) projection
23	Azimuthal orthomorphic polar (stereographic) projection
24	Lambert zenithal equal-area (normal) projection (code is outdated, apply 30)
25	Urmaev sinusoidal pseudocilindrical for oceans maps (Pacific Ocean and Indian Ocean)
26	Aitoff azimuthal equal area
27	cylindrical equidistant projection
28	Lambert Cylindrical equal-area projection
29	ordinary policonical modified (international) projection
30	Lambert azimuthal equal-area oblique projection
31	Transverse cylindrical orthomorphic projection
32	Autogonal topographical projection for system of coordinates 63 year
33	Latitude / Longitude cylindrical on the sphere
34	Miller's cylindrical on the ball ESRI:54003
35	Cylindrical straight conformal of Mercator EPSG:3857/3395
36	Cylindrical straight conformal of Mercator (Mercator 2SP)

The above classification of reference data is not complete, and may be supplemented in the future.

10) Coordinate system (1 byte):

0 or 255	undefined
1	The coordinate system of 42 year (flat rectangular)
2	Universal Transverse Mercator System (USA – Universal Transverse Mercator)
3	National rectangular grid of Great Britain (National Grid)
4	Rectangular local coordinate system (large-scale plans)
5	The coordinate system of 63 year
6	Rectangular conditional for survey maps, depends on the type of projection, the values of the main parallels and the axial meridian
7	Geodesic coordinates in accordance with the ellipsoid in radians
8	Geodesic coordinates in accordance with the ellipsoid in degrees
9	The coordinate system of 95 year (flat rectangular)
10	The coordinate system – Geodetic Coordinate System-2011 (GSK-2011)

The above classification of reference data is not complete, and may be supplemented in the future.

11) The unit of measure (1 byte):

0	meters (or discretes)
64	radians
65	degrees

Meters are used to record elevation values.
The above classification of reference data is not complete, and may be supplemented in the future.

12) Frame type (1 byte):

0	Map is not limited to a frame
1	Trapezoidal without break points
2	Trapezoidal with break points

3	Rectangular
4	Circular
5	Arbitrary
255	undefined

13) The generalized map type (1 byte):

0 or 255	undefined
1	Topographic coordinate system of 42 year (Pulkovo 42)
2	Survey and geographic
3	Special space navigation
4	Topographic city plan (Pulkovo 42)
5	Large scale plan (Nonearth)
6	Aeronautic map
7	Seanautical
8	Aviation
9	Scheme
10	Universal topographical of Mercator North American Datum 1927 (UTM NAD 27)
11	Universal topographical Mercator on WGS84 (UTM WGS 84)
12	Universal topographical Mercator on the own ellipsoid (UTM)
13	Topographical system of coordinates 63 year (Pulkovo 63)
14	Topographical system of coordinates 95 year (Pulkovo 95)
15	Topographic local (with an arbitrary main point)
16	Survey and geographic Latitude / Longitude on the sphere
17	Map of the World (Miller's Cylindrical)
18	Local coordinate system based on Pulkovo 63
19	Cylindrical Mercator on the sphere «World Mercator» (EPSG: 3857, EPSG: 3395)
20	Seanautical (Mercator_2SP)
21	Geodetic Coordinate System-2011 (Pulkovo 2011)
22	Coordinate systemVN-2000 (EPSG:3405, EPSG:3406)
23	Coordinate systemVN-2000/TM-3 (EPSG:6956 – EPSG:6959)

The above classification of reference data is not complete, and may be supplemented in the future. The relationship between the map type and the content of the reference data is described in Appendix 3. There are the rules for formation of the passport data for various types of maps.

14) Kind of the source material (1 byte):

0 or 255	undefined
1	Mappable
2	Photoplan
3	Image
4	Photogrammetric

15) Type of the source material (1 byte):

0 or 255	undefined
1	Map copy
2	Publishing original
3	Compilation manuscript
4	Modified manuscript
5	Special manuscript
6	Diapositive constant keeping
7	Photogrammetric material (PGM)
8	PGM and run

9	PGM and compilation manuscript
10	PGM and final manuscript
11	PGM and diapositive constant keeping
12	PGM and special manuscript
64	Space
65	Aero
66	Photogram

The above classification of reference data is not complete, and may be supplemented in the future.

16) The features of filling in the data projection.
For the generalized map type «Topographic local» (15), the fields are filled in as follows:

Field assignment	Contains
The first main parallel	zero
The second main parallel	value of the scale factor «ScaleFactor»
Axial meridian	value of the longitude of the main point
Parallel of the main point	value of the latitude of the main point
Offset to the north	value of the latitude offset in meters «FalseNorthing»
Offset to the east	value of the displacement in longitude in meters «FalseEasting»

2.1.2 The structure of the data descriptor

The area of data record, in the SXF format, starts with the data descriptor. The descriptor contains information used to control and restore the structural integrity of the format.

The data descriptor has the following structure:

Table 2 - The structure of the data descriptor

Field assignment	Offset	Length	Comment
The identifier of data	+ 0	4	0x00544144 (DAT)
Length of descriptor	+ 4	4	= 52
Nomenclature of the sheet	+ 8	32	ANSI
Number of data records	+ 40	4	
Information flags – The flag of data state – The flag of the projection conformity – The flag for presence of real coordinates – The flag of coding method – The flag of generalization – The flag of the title coding – Secrecy mark – The flag of automatic reference GUID objects – The flag of date and time reference for editing objects – Reserve	+ 44	4 2 bits 1 bit 2 bits 2 bits 1 bit 1 1 1 bit 1 bit 6 bit	 Note 1. Note 2. Note 3. Note 4. Note 5. Note 6. Note 7. 1 – it is assigned automatically to GUID objects 1 – it is automatically assigned the service of semantics = 0

Field assignment	Offset	Length	Comment
Reserve	+ 48	4	= 0
TOTAL : 52 Bytes			

Notes:

1) The flag of data state (2 bits):

xxxxxx11 data in State 3 (format of data exchange)

2) The flag of the projection conformity (1 bit):

xxxxx0xx the data do not correspond to the projection (the map may have a rotation relative to the true position and some deformation)

xxxxx1xx the data corresponds to the projection

3) The flag for presence of real coordinates (2 bits):

xxx00xxx the entire metric of the objects is represented in the conditional coordinate system (in discretes)

xxx11xxx the entire metric of objects is represented in real coordinates on the terrain in accordance with the sheet's passport data (projection, coordinate system, unit of measure), data on the scale and discreteness of the digitization have a reference character

4) The flag of coding method (2 bits):

x00xxxxx classification codes of objects and semantic characteristics are represented by decimal numbers recorded in binary form (for example: code of the object «32100000» is recorded in the form 0x01E9CEA0, the semantics code «253» is in the form 0x00FD)

5) The flag of generalization (1 bit):

0xxxxxxx the level of generalization is specified by the table of small-scale maps (described in Table 4)

1xxxxxxx the level of generalization is specified by the table of large-scale maps (described in Table 5)

6) The flag of the title coding for objects (1 byte):

0 encoded ASCIIZ (Dos)
1 encoded ANSI (Windows)
2 encoded KOI-8 (Unix)

7) Secrecy mark (1 byte):

0 undefined
1 open information
2 information with restricted access
3 information for official use
4 classified information
5 top secret information

The data area consists of variable length records. One entry is per one data object.

The record contains a standard header with the length of 32 bytes and data of variable length – the metric and semantics of the object. The title (header) of the record indicates the total length of the record.

2.1.3 Description of the record header

2.1.3.1 The structure of the record header

Table 3 - The header structure for record of object

Field assignment	Offset	Length	Comment
The identifier of the record begining	+ 0	4	0x7FFF7FFF
The total record length	+ 4	4	with the title (header)
Length of the metric	+ 8	4	in bytes
The classification code	+ 12	4	
Own object number – Number in the group – Group number	+ 16	4 2 2	
Reference data – Nature of localization – Multi-polygon Reserve – The attribute of compression for graphics – The presence of semantics – The size of element metric – The presence of the vector binding – The attribute of text in UNICODE – The attribute of displaying the object higher than all – The attribute of displaying the object lower than all – The attribute of aligning the sub-objects vertically – The format of the metric record – Dimension of the representation – The type of the element metric – The attribute of the metric with text – The presence of graphics (sign) – The scalability of graphics – The attribute of spline construction by metric	+ 20	3 4 bits 1 bit 3 bits 1 bit 1 bit 1 bit 1 bit 1 bit 1 bit 1 bit 1 bit 1 bit 1 bit 1 bit 1 bit 1 bit 1 bit 2 bits	 Note 1. 1 – polygon sub-objects can be outside the object It must be zero 1 – the sign of the graphic object may be compressed Note 2. Note 3. Note 4. 0 – single-byte text, 1 – UNICODE. 1 – display above all 1 – show below all 1 – align the vector objects Note 5. Note 6. Note 7. Note 8. Note 9. Note 10. Note 11.
Generalization level – Lower bound of visibility – Upper bound of visibility	+ 23	1 4 bits 4 bits	Ni = 0...15 N1 15 – N2

Field assignment	Offset	Length	Comment
Number of the metric points for large objects	+ 24	4	If in the next field value 65535
Metric description – Number of sub-objects – Number of metric points	+ 28	4 2 2	 65535 for large objects
TOTAL :	32	Bytes	

Notes:

1) The character of the localization (4 bits, for SXF versions up to 3.0 – 2 bits):

xxxx0000 Linear object (polyline)
xxxx0001 Polygonal object (the first and the last point of the metrics coincide)
xxxx0010 Dotty object (symbol)
xxxx0011 Title
xxxx0100 Vector (oriented object, contains two points in the metric)
xxxx0101 Template of titles – the first metric point is the template anchor point, the sub-object metric specifies the location of titles and auxiliary lines («blank title»)

2) The presence of semantics on the object (1 bit):

xxxxxx0x there is no semantics
xxxxxx1x there is semantics

3) The size of metrics element (1 bit):

Value	For an integer value	For a floating value
xxxxx0xx	2 bytes	4 bytes
xxxxx1xx	4 bytes	8 bytes

4) The presence of a binding vector (1 bit):

xxxx0xxx there is no description of the binding vector
xxxx1xxx behind the record of the metric there is a description of the vector of the 3D model binding

5) The format of metric recording (1 bit):

xxxxxxx0 metric is recorded in a linear format
xxxxxxx1 metric is recorded in a vector format

6) Presentation size (1 bit):

xxxxxx0x object has the two-dimensional view
xxxxxx1x the object has the three-dimensional representation

7) The type of the element metric (1 bit):

xxxxx0xx coordinates of points (X,Y) is represented as integers
xxxxx1xx coordinates of points (X,Y) is represented as real numbers

The height (H) is always given as a number with floating-point.

8) The attribute of the metric with text (1 bit, for SXF versions 3.0 and older):

xxxx0xxx metric contains only the coordinates of points
xxxx1xxx metric contains the text of the titles (only for objects type «Title» or «Templete of titles»)

9) The presence of graphics (sign) (1 bit, for SXF versions 3.0 and older):
xxx0xxxx object record does not contain a graphic description of object
xxx1xxxx graphic description of the object (a conventional sign) follows the metric of object

10) The scalability of graphics (sign) (1 bit, for SXF versions 3.0 and older):
xx0xxxxx the object's conventional symbol is not scalable
xx1xxxxx the object's conditional sign is scaled when displayed

11) The attribute of spline construction by metric (2 bits, for SXF versions 3.0 and older):
00xxxxxx the spline is not built during visualization
01xxxxxx smoothing spline (cutting corners)
10xxxxxx it is the envelope spline (passes through all points of the metric)

2.1.3.2 The rules for formation of the record header

The header of the data record consists of 8 parts (each with a length of 4 bytes):

1) The identifier of the record start – has a constant value (hexadecimal number 0x7FFF7FFF), it used to control the integrity of the record structure and when data is restored;
2) The total length of the record is the length of the data record, including the title;
3) The length of the metric is the length of the metric record of the object, including the metric of the object and sub-object. If the record has a graphic description and a binding vector – their length is also included in the length of the metric. The offset to semantics in the record is: the length of the metric plus the length of the header;
4) The classification code determines the type of the object by specifying 4-byte code from the corresponding classifier table. The table number is specified in the passport file (duplicated in the descriptor) and it depends on the scale of the source material, the national map system and other. Examples of classifiers are given in Appendix 4.
5) The object's own number is a unique object number that uniquely identifies it. It can be conditionally divided into two parts or perceived as a whole four-byte field. The object number is used in the procedures for updating and correcting data, as well as for organizing logical connections with other objects or records of the external database;
6) Reference data are used to monitor the quality of the metric and perform processing procedures;
7) The level of generalization is formed according to the following rules:

- The upper bound of the visibility determines the maximum map scale at which this object is visible on the map;
- The lower bound of visibility determines the minimum map scale at which the object is visible on the map;
- The ratio of the level of generalization and scale for small-scale maps (smaller than 10 000) is shown in Table 4, for large-scale it is in Table 5. The type of the table used should be indicated in the information flags of the passport sheet.

Table 4 - Maps of the scale smaller than 1:10 000

Generalization level	0	1	2	3	4	5
Image scale	<=500	1000	2000	5000	10000	25000

6	7	8	9	10	11	12	13	14	15
50 thous	100 thous	200 thous	500 thous	1 mln	2 mln	5 mln	10 mln	20 mln	>= 40 mln

Example: The Generalization level field contains the value 0x24.
The lower bound of visibility is 4, corresponding to 1:10 thousand;
The upper limit is 13 (15-2), corresponding to 1:10 mln.

Table 5 - Maps of scale 1:10 000 and larger

Generalization level	0	1	2	3	4	5
Image scale	<=5	10	25	50	100	200

6	7	8	9	10	11	12	13	14	15
500	1000	2000	5000	10000	25 thous	50 thous	100 thous	200 thous	>=500 thous

- If this field is equal to 0x00, it means that this object is visible at all scales display;
- If this field is blank, it should contain the pseudo-code equal to 0xFF (this should be installed by default);
- Converting the visibility boundaries from a large-scale map (Vl) to a small-scale (Vs) and vice versa, the following transformations are performed: Vs = Vl – 6, if Vs <0, then Vs = 0; Vl = Vs + 6, if Vl> 15, then Vl = 15.

Number of the metric points for large objects – contains the number of metric points for objects when this number is greater than 65535. In this case, the following field **Number of metric points** contains the value 65535 (the rule was introduced from version 4.0 to support objects with any number of points).

The field **Number of sub-objects** is filled according to the following rules:
- The sub-objects are:
- portions of the surface areal type (i.e. not linear ones and not point ones), which are located inside the outer boundary of the area and does not belong to it;
- borders of the sub-objects are the internal boundaries of objects;
- sections of a linear object having an independent metric, and having the logical extension of the object, and having the same semantic characteristics as the object itself;
- titles, arranged in several rows, when each row has its own anchor (binding) points.

Objects having the sub-objects, have in the field **Number of sub-objects**:
- for area objects – the number of sub-objects;
- for linear objects – the number of constituent linear object elements minus one (only the number of «continuations»);
- for titles – the total number of lines minus one;
- objects that do not have sub-objects having a value of zero in the field Number of sub-objects.

Note:

As a rule, sub-objects are formed when two area objects overlap (for example, an island on a river or a lake in a forest). In this case, the metric of the object located inside, it is duplicated as the metric of the sub-object. Creating sub-objects in these cases, it is not necessary (if in the future this will not affect the calculation of areas, heights, and so on).

The field **Number of metric points** contains the number of points in the object's metric. The object's metric follows this field.

2.1.4 The structure of the object's metric

The metric of the digital map object is stored in the coordinate system of the device (device) on which it was received (tablet, scanner, etc.). To obtain the real coordinates of the object, it is additionally necessary to use the data from the passport file: the projection of the source material, the scale, the resolution of the device (devices), and others.

The metric of the object is the consecutive coordinates of the points for the contour of the object or the coordinates of the anchor (binding) point for objects that do not have a digitized contour (point objects, titles, etc).

The first is the coordinate X (measured from the lower left corner up), then the coordinate Y (measured from left to right). If the object has a three-dimensional view, then the coordinate H is the height of the metric point. The length of the field allocated for the recording of the coordinates of one metric point can be determined from the record header (minimum 4 bytes – short integer two-dimensional, maximum – 24 bytes – long floating-point three-dimensional).

For **two-dimensional** representation of the object, the metric entry looks like:

X1	Y1		X2	Y2	…	Xn	Yn

For **three-dimensional** representation of the object, the metric entry looks like:

X1	Y1	H1		X2	Y2	H2	…	Xn	Yn	Hn

n – number of metric points for the object (indicated in the header of the record).

If the object has sub-objects, then the metric of the object follows the metric of the sub-object of the same kind. Immediately before the sub-object metric, a service field of 4 bytes in length is recorded as follows:

2 bytes – reserve (it is desirable to write zero);
2 bytes – number of the metric points in the sub-object.

For **two-dimensional** representation of the object, a metric record with one sub-object has the form:

X1	Y1	…	Xn	Yn		N1	N2

X1	Y1	…	Xm	Ym

For **three-dimensional** representation of the object, a metric record with one sub-object has the form:

X1	Y1	H1	…	Xn	Yn	Hn		N1	N2

X1	Y1	H1	…	Xm	Ym	Hm

n – number of points for the object's metric (indicated in the header of the record),
m – number of metric points of the sub-object (indicated in the field N2).

If the object has more than one sub-object, the metric of the second and subsequent sub-objects is recorded sequentially one after another. Each metric begins with a service field containing the sub-object number and the number of points of the given metric.

The coordinate value in the floating-point representation is a sign. One coordinate can occupy 4 bytes (FLOAT) or 8 bytes (DOUBLE) in accordance with the standard IEEE for floating-point numbers.

The coordinate value in the plan for the integer representation must be positive and can be in the range from 0 to 65535 for a two-byte metric element or in the range from 0 to 4294976395 for a four-byte metric element.

The count can be taken from a point below the lower left corner of the source material, if there are metric points below this angle.

For three-dimensional representation of an object's metric, the height value always has a floating-point representation format with single or double precision. The height element can be 4 bytes (FLOAT) when the x and y coordinates occupy 2 or 4 bytes, or 8 bytes (DOUBLE), if x and y occupy 8 bytes each.

The heights value is recorded in accordance with the chosen heights system, the projection of the source material and the unit of measurement specified in the passport record. It is recommended to specify the heights in meters.

If the metric is recorded in **Vector** format, the coordinates are counted from the position of the previous metric point. The coordinate value for the integer representation is signed and can be in the range from -32767 to +32767 for a two-byte metric element or in the range -2147483647 to +2147483647 for a four-byte metric element.

To improve the accuracy for monitoring the metrics of objects that come out on the frame, it is recommended that one record be selected to describe the sheet border metric. In the classifier, the code for the sheet border must be provided. If such code is available, it is necessary to write it in the passport of the sheet – in the field **Classification code of the object frame**.

Note:

The metric of objects can be represented in the real coordinate system on the terrain (in meters, radians, etc.), thus the results of field observations can be presented or the data from another format converted. In this case, you must follow the rules described in Appendix 5. Objects of type «Title» must have more complex metric structure for describing the text of title (for SXF versions 3.0 and older).

The metric of title (Metric with text) has the following form:

X1	Y1	…	Xn	Yn	L	TEXT OF TITLE	0

n – number of points for the object's metric (indicated in the header of the record);

L – length of the title in bytes, excluding the trailing zero and the title length field (one byte is allocated for the length field and the trailing binary zero).

Coordinates of metric points have the same form as for other types of objects.

The text of the title is placed behind the coordinates of the metric points in the ANSI encoding. If the field **Text attribute in UNICODE** in the header of the record is set to 1, then the text of the title in the UTF-16 encoding (2 bytes per character).

The text length in bytes is recorded before the text of the title. After the text of the title, there should be a binary zero.

Therefore, the total length in bytes occupied by the description of the title text is equal to the length of the title plus two. But the actual number of characters in the text can be less than the length of the text. In the length of the text, extra zero characters can be included to equalize the total length of the title description to a multiple of the coordinate length of the point (2.4 or 8). For encoding UTF-16, the length of the text usually includes 2 zero bytes behind which is the final zero byte. In addition, for the first zero character (for UTF-16 after the first two zero bytes), the text alignment symbol can be located in the text, as described in Appendix 6.

The description of the title text can consist of two binary zeros (an empty title). This feature can be used to build title templates that contain other kinds of conditional signs (lines, dot symbols and so on). In this case, an empty title describes the metric of additional objects.

The object of **Title** type can have sub-objects. The metric of the sub-object should have the same form as the metric of the object (that is, it has a handle to the title text). The number of sub-objects is indicated in the header of the record.

X1	Y1	…	Xn	Yn	L1	TEXT OF TITLE1	0	N1	N2
X1	Y1	…	Xm	Ym	L2	TEXT OF TITLE2	0		

n – number of points for the object's metric (indicated in the header of the record);
m – number of metric points of the sub-object (indicated in field N2);
L1 – field containing the text length of the object;
L2 – field containing the text length of the sub-object;
N1 – reserve;
N2 – field containing the number of metric points in the sub-object.

If **Metric with text** is not set for **Title** type object, then the inscription texts are located in the semantics of the object in sign (character) characteristics. The number of sign characteristics must be greater than the number of sub-objects.

2.1.5 The structure of graphic description for the object

As a rule, the objects of the digital map should be described in the map classifier. In the object description, the external object code, layer, conditional sign and other parameters are indicated. However, for drawing auxiliary graphic information (explanatory titles, auxiliary lines, polygons, etc.) it is more convenient to use arbitrary graphic primitives without their preliminary description in the classifier. To this purpose, graphic objects are created.

A graphical map object is an object that does not have a description in the classifier, but has metric, semantics, layer, unique number and a conventional sign. A conditional character is stored in the object description on the map.

When transferring data in the SXF exchange format, the symbol is stored together with other parameters of the object.

In this case, the field **Presence of graph** for the title (header) record of the object should be set to 1. The record of the graphic description is located behind the metric of the object. Its length is included in the length of the metric.

The structure of recording the graphic description for the object has the following form:

Table 6 - The structure of graphic recording

Field assignment	**Offset**	**Length**	**Comment**
The identifier of the record start	+ 0	4	0x7FFF7FFE
Total recording length	+ 4	4	with title (header)
Number of primitives	+ 8	4	
Description of primitives	+ 12	S	S – size of description (bytes).
TOTAL	: 12 bytes	+	length of description

The description of the graphic primitive is as follows:

Table 7 - Description of a separate primitive

Field assignment	**Offset**	**Length**	**Comment**
The length of description	+ 0	2	In bytes

Field assignment	Offset	Length	Comment
The type of primitive	+ 2	2	
The parameters of primitive	+ 4	S	S – size of description (bytes).
TOTAL	: 4 bytes	+	length of description

Types of primitives and their parameters are given in Appendix 7.

2.1.6 The structure of description for vector binding of 3D object model

At constructure a three-dimensional model of a terrain along a vector map, the description of the object can be supplemented with a vector of binding for the three-dimensional model of the object.

The three-dimensional model of the object is stored in the 3D image library (P3D) and it has a three-dimensional spatial reference to the first point of the object's metric – displacement (offset) and rotation.

The binding parameters, the library name and the model identifier are stored in the binding vector record, which has the following structure:

Table 8 - Description for the record of the 3D vector

Field assignment	Offset	Length	Comment
The identifier of the record start	+ 0	4	0x7FFF7FFD
Total recording length	+ 4	4	with title (header)
Offset of the model along X axis	+ 8	8	In meters
Offset of the model along Y axis	+ 16	8	In meters
Offset of the model along H axis	+ 24	8	In meters
Angle of the model rotation in X	+ 32	8	In degrees
The code of model in the library	+ 40	4	
The file name of the library	+ 44	S	S – size of string (bytes). It is supplemented with zeros for multiplicity 4
TOTAL	: 44 + S	bytes	

The fields with length of 8 bytes have the format with floating point of IEEE standard, if there are no data, the fields contain the value zero.

2.1.7 The structure of the object’s semantics

The data area for semantics consists of variable-length data blocks.

The semantics data block has the following structure:

Table 9 - Description for the record of semantics

Field assignment	Offset	Length	Comment
The code of characteristics	+ 0	2	
The code of the block length – The type of characteristic – The scale factor	+ 2	2 1 1	 Note 1. Note 2.

The value of the characteristics	+ 4	S	S – size of string (bytes)
TOTAL : 4 + S bytes			

Notes:

1) The type of characteristic (1 byte):

0 character in ASCIIZ (DOS)
1 integer (1 byte)
2 integer (2 bytes)
4 integer (4 bytes)
8 floating point in the IEEE standard (8 bytes)
126 character in ANSI (WINDOWS)
127 character in UNICODE

2) The scale factor (1 byte 1):

- For the character field is the number of characters excluding trailing zero (up to 255 characters per line).
- For the digital integer field is a power of 10, the scaling factor for numbers with a fractional part or large numbers. The scale factor can take values from -127 to +127.

Blocks are recorded directly behind the metric of the object and the sub-object, one after another without any separators. The number of data blocks corresponds to the number of characteristics for semantics of this object.

Example 1:
Recording **The relative height of the object 127.3 m** can look like:
0x0001 0x02 0xFF 0x04F9,
where 0x0001 – it is the height code for one of the classifiers (specified in the passport file);
0x02 – it is a 2-byte digital field code;
0xFF – it is the value of the degree – minus one;
0x04F9 – it is the number 1273 (the measurement system is set in the passport)

or 0x0001 0x00 0x07 0x31 0x32 0x37 0x2C 0x33 0x20 0xAC 0x00,

that is, in the form of a symbol string «127.3 m».

Example 2:
Recording **Object name – MOSCOW** will look like:
0x0008 0x00 0x06 0x8C 0x8E 0x91 0x8A 0x82 0x80 0x00,
where 0x0008 – it is the code of the object's own name;
0x00 – it is the code of the character field;
0x06 – it is length of the field without trailing zero;
0x8C ... 0x80 – the string (line) «MOSCOW» in the ASCII code;
0x00 – it is the end-of-line character (attribute) for ASCIIZ.

Example 3:
Recording **Object material – brick** can have three types:

- in the form of a symbol string «brick»;
- in the form of a numeric field, where the field value is a material code of «brick» type from the corresponding classifier;

- in the form of the character string «XXX» – where XXX is the symbolic entry of the material code of the «brick» type.

The choice of the form for representation of semantics in this case depends only on the classifier of semantics. If the chosen classifier provides the presence of codes for values of the characteristic, then it can be recorded only in the form b) or c), otherwise only in the form a).

To record string values of the **arbitrary length**, it is used the data block of the extended structure (Table 10). The field of **Type of characteristic** is set to 128, in the field **Scale factor** to 0xFF. Then there is an additional field **Length of the value** in which the length of the string is recorded, including two bytes with a zero value. The string has always the code UTF-16.

Table 10 - Description of the individual characteristics

Field assignment	**Offset**	**Length**	**Comment**
The code of characteristics	+ 0	2	
The code of the block length – The type of characteristics – The scale factor – The length of the value	+ 2	6 1 1 4	 128 0xFF Including trailing zeros
The value of the characteristics	+ 8	S	S – size of string (UTF-16) = length of string x 2 (bytes)
TOTAL : 8 + S bytes			

APPENDIX 1 THE RULES FOR METADATA RECORDING, SUPPLEMENTING THE MAP PASSPORT

To store the extended passport data in a key presentation form, it can be used the semantics of the **service object** or the semantics of **The frame** (border) **of sheet** object.

The service object is recorded to the SXF file first, directly behind the data descriptor. In the fields Classification code and Own object number must be zeros. In the metric of the object there can be one point with the coordinates of the south-western corner of the map dimensions. When reading SXF, the service object may not be applied to the map, but its semantics must be processed to properly generate the metadata of the digital map. The metadata values in the semantics of the service object must not conflict with the values of the fields in the map's passport.

To search for the object The frame of sheet is required from the sheet passport to take the classification code of the sheet frame. Then find the object in which the header of the entry contains this code. There can be only one such object in the sheet.

Table 11 - Examples of possible semantic characteristics for recording the map metadata

The digital code	**Assignment**	**The units of measurement**
32871	Shift on the X-axis (DATUM)	Meters
32872	Shift on the Y axis (DATUM)	Meters
32873	Shift on the Z axis (DATUM)	Meters
32874	Rotate around X axis (DATUM)	Seconds
32875	Rotate around Y axis (DATUM)	Seconds
32876	Rotate around Z axis (DATUM)	Seconds
32877	Scale element (DATUM)	
32878	Type of conversion DATUM to WGS-84 (PZ-90.02	0 – no conversion, 3 – the transformation of Molodensky, 7 – Helmert transformation, 14 – Helmert transformation to PZ-90.02
32879	Scale on the axial meridian	
32880	Length of the semiaxis for the ellipsoid	Meters

The digital code	Assignment	The units of measurement
32881	Polar flattening (compression) of the ellipsoid	
32882	The identifier of the coordinate system	Line
32883	The name of the map sheet	Line UTF-16
32884	The nomenclature of the map sheet	Line UTF-16
32885	The name of the district (the group of sheets)	Line UTF-16
32886	The identifier of the data set	Line (it is usually 32 hexadecimal characters)
32890	The type for transformation of the coordinate system	1 – shift, scale, rotation 2 – affine transformation
32891-32900	The parameters for transformation of the coordinate system	(1) Angle, scale, X and Y offset; (2) 6 coefficients of the affine transformation
50120	The area covered by the nomenclature sheet	sq. km
50203	Date on which given the declination of the magnetic needle	YYYYMMDD
50204	The annual change in the declination of the magnetic needle	Radians
50210	Maximum declination of the magnetic needle	Radians
50211	Minimum declination of the magnetic needle	Radians

Characteristics for which there is a corresponding field in the record of the passport for the sheet, it must be entered in the field of the passport.

APPENDIX 2 THE PROCEDURE FOR CALCULATING THE CHECKSUM OF A FILE

The checksum of the file is used to check the security of the information in the SXF file, it is stored in the field **Checksum** of the passport record. The checksum is generated by arithmetic addition every byte of the SXF file. In this case, the field **Checksum** is considered to be zero.

Note: This procedure for calculating the checksum is only valid for edition 2.3 and newer.

APPENDIX 3 THE RULES FOR FORMATION OF THE PASSPORT DATA FOR VARIOUS TYPES OF MAPS

1) Map type: Topographic 42 (1) Survey and geographical (2)

	Topographic 42 (1)	Survey and geographical (2)
Ellipsoid	: Krasovsky (1)	Krasovsky (1)
Verticl datum	: Baltic (1)	Baltic (1)
Projection	: Gauss – Kruger (1)	(2) – (15)
Coordinate system	: System of 42 year (1)	rectangular (6)
Frame type	: trapezoidal (1,2)	rectangular (3), or (1) – (4), depends on projection

2) Map type: Space navigaion (3)

Ellipsoid : Krasovsky (1)
Verticl datum : Baltic (1)
Projection : cylindrical special (3)
Coordinate system : undefined (-1)
Frame type : rectangular (3)

3) Map type: Topographic plan (4) Large-scale plan (5)

	Topographic plan (4)	Large-scale plan (5)
Ellipsoid	: Krasovsky (1)	Krasovsky (1)
Verticl datum	: Baltic (1)	Baltic (1)
Projection	: Gauss – Kruger (1)	undefined (-1)
Coordinate system	: System of 42 year (1)	local (4)
Frame type	: rectangular (3)	rectangular (3)

Map type : Aerial navigation (6)

Ellipsoid : Krasovsky (1)
Verticl datum : Baltic (1)
Projection : conformal conic (2) or modified polyconic (11),
Coordinate system : local for each sheet (4)
Frame type : trapezoidal (2)

Map type : Topographical UTM WGS of 84 year (11)

Ellipsoid : International of 84 year (9)
Verticl datum : Baltic (1)
Projection : UTM (17)
Coordinate system : Mercator projection system (2)
Frame type : trapezoidal (1,2)

Map type : Topographical of 63 year (13)

Ellipsoid : Krasovsky (1)
Verticl datum : Baltic (1)
Projection : Gauss – Kruger (1)
Coordinate system : System of 63 year (5)
Frame type : rectangular (3)

Map type : Topographical of 95 year (14)

Ellipsoid	:	Krasovsky (1)
Verticl datum	:	Baltic of 77 year (25)
Projection	:	Gauss – Kruger (1)
Coordinate system	:	System of 95 year (9)
Frame type	:	trapezoidal (1,2)

APPENDIX 4 EXAMPLES OF CLASSIFIER TABLES

1) Classifier of topographic information for maps and plans of scales 1:500, 1:1 000, 1:2 000, 1:5 000, 1:10 000

Table 12 - Example of the object classifier

The name of the object	**The code of the object**
Building	0001
Well	0002
Construction	0003
Sidewalk (pavement)	0004
Transformer	0046
Tower	0047
Street	0048
Reef	0240
Crib pier	0241
Fault (throw)	0242
Pile	0243

Table 13 - Example of the semantics classifier

Name of characteristics	**Code of characteristics**
Functional or natural qualities	00001*
Feature of construction or natural structure	00002*
Purpose	00003*
Condition (status)	00004*
Material	00005*
The height of the shore	06101
The height of the ridge	06102
. . .	. . .
The height of the upper (top) point	06113
The depth of the bottom	06201
. . .	. . .
Sagged wires (example: on the power line)	06205
. . .	. . .
The width of the narrow part	06801

Name of characteristics	Code of characteristics
. . .	. . .
The proper name	08200
The inscription	08300
Number	08400
The absolute height of the bottom	08518
. . .	. . .
The absolute height of the curb	08538
. . .	. . .
The relative height of the floor	08647
. . .	. . .

Note: For feature (characteristics) codes which marked with an asterisk (*), the characteristic value can be represented as a value code, if to describe the code classifier (see page 27, page 31).

2) Classifier of topographic information for maps of scales 1:50 000, 1:100 000

Table 14 - Example of the object classifier

The name of the object	The code of the object
Reference points	11000000
Points of State Geodetic Net	11200000
The points of Geodetic survey network	11300000
Points of the level network	11400000
. . .	. . .
Oceans and seas	31110000
Lakes	31120000
Reservoirs	31131000
. . .	. . .
Cities	41100000
Urban settlements	41200000
Villages of rural type	42100000
Individual yards	42200000

Table 15 - Example of the semantics classifier

Name of the characteristic	The code of the characteristic
Relative height	00001
Length	00002

Name of the characteristic	The code of the characteristic
Condition (state)	00003
Absolute height	00004
Maximum height	00006
Depth	00007
Nature of the rock	00008 *
. . .	. . .
Distance	00024
High water mark	00025
. . .	. . .
Road number	00053
. . .	. . .
Pass ability	00063 *
The number of the forest block	00064

Table 16 - Example for the classifier of semantic values

The value of the characteristic	The code of the characteristic
Characteristics – rock character (00008)	
Hard rock	00001
Loose rock	00002
Characteristic – cross-country capability (pass ability) (00063)	
Passable	00001
Impassible	00002
Walking in the dry time	00003

APPENDIX 5 THE RULES OF FORMING THE METRIC DATA FOR CONVERTERS IN FORMAT SXF AND BACK

At placing coordinate data about real or conditional objects of the terrain in the SXF format, it is necessary to fill correctly the passport data and the observance of dependencies between different coordinate systems.

At placing REAL COORDINATES in SXF format WITHOUT CONVERSION into the conditional coordinate system, the following rules should be fulfilled:

- the metric of objects is filled in meters, radians or degrees (floating-point format, 8 bytes);
- the values of the coordinates must correspond to the values of the unit of measurement indicated in the passport, the coordinate system, the elevation (heights) system, etc (described in the MATHEMATICAL BASIS OF THE SHEET);
- for user maps, in the field of the passport **Information flags**, the flag of the presence of real coordinates must be non-zero;
- for all maps in the passport field **The coordinate accuracy flag** should be the corresponding value (1 – increased accuracy of coordinates storage in meters, radians or degrees, 2 – coordinates are recorded in meters to within a centimeter, 3 – coordinates are recorded in meters to within a millimeter) ;
- for all maps in the passport field **The unit of measurement** must be the corresponding value (0 meters, 64 – radians, 65 – degrees).

At processing various images of the terrain (paper maps, photographic plans, photographs, etc.), it is often used the concepts: COORDINATE SYSTEM OF DEVICE and CONDITIONAL COORDINATE SYSTEM. This is due to the use of digital instruments having discrete image presentation fields (for example, a scanner with X dpi scanning resolution (dots per inch, 1 inch about 2.54 cm), a digitizer with Y dpi resolution, etc.).

After entering the terrain objects into the computer using digital instruments, they can be presented in COORDINATE SYSTEM OF DEVICE. For example, after scanning a map with size 50 by 50 cm on a scanner with a resolution of 300 dpi (11811 points per 1 meter), we get a discrete field of 5906 pixels at 5906 points. Each point of the terrain image will be represented by coordinates (row number and line number). In this case, the upper left corner of the image can be the reference point.

In the process of digitization (vectorization), there are selected only those points that correspond to contours or binding points of the terrain objects. In this case, the coordinates of the points (DISCRETES) are converted to the CONDITIONAL COORDINATE SYSTEM, where the coordinate axes are directed: X – from bottom to top, Y – from left to right. This corresponds to the rectangular coordinate systems used in topography. In addition, the resulting coordinates can be transformed by turning the objects to a given projection, stretching and compressing the objects which are necessary to account for the deformation.

As a result, a simple transition to the real coordinates of objects on the terrain can be performed from the resulting coordinate system. To do this, you need to know the scale of the source material, the number of points (discrete) per meter (the resolution of the device), the coordinates for the reference point of the conventional coordinate system on the terrain.

For example: We have a device with a resolution of 20,000 points per meter, the source material has a scale of 10,000, the coordinates of the reference point are 6,500 m and 8,000 m. Determine the coordinates of the point on the terrain, if its coordinates in the conditional system are 2,000 and 1,000 discrete.

If 20,000 points are 1 meter of image, then 2,000 points are 0.1 meters, and 1,000 -0.05 meters.

If 1 meter of the image is 10 000 meters of terrain (this is the scale), then 0.1 meters – 1,000 meters in the terrain, and 0.05 – 500 meters on the terrain.

Then the final coordinates are: X = 6 500 1 000 = 7 500 (m), and Y = 8 000 500 = 8 500 (m).

Thus, the coordinates of any point on the terrain Xp, Yp are equal to:

Xp, Yp (m) = Xo, Yo (m) (Xd, Yd / R * S), (1) where Xo, Yo are the coordinates of the reference point of the conditional coordinate system on the terrain,

Xd, Yd – the coordinates of a given point in the conditional coordinate system (in discretes),

R – resolution of the device (discrete per meter),

S – scale of the image, which was used for the digitization of terrain objects.

Then, for the reverse transition from the real coordinate system to the conditional one,

$Xd, Yd = (Xp, Yp\ (m) - Xo, Yo\ (m)) / S * R.$ (2)

At placing real coordinates in the SXF format with scaling and introducing the conditional coordinate system, it must be observed the dependencies represented by the expression (2).

Such problem can arise when generating data in the SXF format, which must be processed by software operating with a conditional coordinate system.

Suppose that we want to convert the coordinates of the objects on the section corresponding to the map sheet at a scale of 1: 10,000. In this case, the metric entries must be double-byte. The coordinates of the objects were obtained in an unknown way and there is no data about the device. We limit the maximum value of coordinates in discretes to 30 000 (this can be placed in two bytes). Define the maximum difference in the coordinates for all pairs of objects (that is, the size of the image fragment on the terrain). Approximately it can be estimated as follows: for a scale of 1: 10,000, an image of 50 by 50 cm will have a size of 5,000 by 5,000 meters. In this case, the resolving power of the conditional device based on (2) will be:

$R = Xd, Yd\ max / (Xp, Yp - Xo, Yo)\ max * S.$ (3)

That is: $R = 30{,}000 / 5{,}000 * 10{,}000 = 60{,}000$ (discrete / meter).

In this case, the accuracy of the representation on the terrain (P) will be:

$P = S / R$ (meters / discrete). (4)

In our example: $P = 10{,}000 / 60{,}000 = 0.166$ (meters / discrete).

Or in the image of the area (on the map) 0.00166 mm.

After that, having defined R, S and Xo, Yo, we can use expression (2) to determine the coordinates of objects recorded to the SXF format.

Thus, for transition to the conditional coordinate system, it is necessary to select the scale of the conditional system and determine the resolving power of the conditional device for the given accuracy of data representation in the conditional system.

To solve the inverse conversion problem from SXF format and transition to real coordinates, it is used the expression (1) and data from the passport. Further from the rectangular coordinate system, the transition to geodetic coordinates is performed. For this, it is necessary to take into account the projection of the conditional coordinate system and the geodetic coordinates of the initial point.

APPENDIX 6 THE LOCATION OF TITLES RELATIVE TO THE METRIC

To indicate the way of the title position relatively to its coordinates, a service symbol (byte) is used, which is located after the first zero byte in the text of the title. In this case, the text length field indicates the total length of the data between the text length field and zero field of ending for the description of title.

L	The text of title	0	C	…	0

The service symbol (designated as C) can take the following values:

	Text is aligned to the left	Text is aligned to the right	Text is aligned to the middle line
Lower edge of the symbols along the segment	20	21	22
Segment divides the inscription in half in height	23	24	25
Upper edge of the dimensions of the symbols along the segment	26	27	28
Lower edge of the dimensions of the symbols along the segment	29	30	31

If the service symbol is missing (the length of the inscription is equal to the number of characters in the text) or takes a value that is not defined, the inscription is displayed at the bottom of the characters and it is pressed to the left.

APPENDIX 7 TYPES OF GRAPHIC PRIMITIVES AND THEIR PARAMETERS

Table 17 - The simple line, the code of type primitive 128

Field assignment	Offset	Length	Comment
The color of the line	+ 0	4	RGB
The thickness of the line	+ 4	4	in microns
Total: 8 bytes			

Table 18 - The dashed line, the code of type primitive 129

Field assignment	Offset	Length	Comment
The color of the line	+ 0	4	RGB
The thickness of the line	+ 4	4	in microns
The length of the stroke (bar)	+ 8	4	in microns
The length of the gap	+ 12	4	in microns
Total: 16 bytes			

Table 19 - The areal object, the code of the type primitive 135

Field assignment	Offset	Length	Comment
The color of the area (square)	+ 0	4	RGB
Total: 4 bytes			

Table 20 - The point object, the code of type primitive 143

Field assignment	Offset	Length	Comment
The length of parameters	+ 0	4	in bytes
Number of colors in the sign	+ 4	4	RGB
The side dimension of the sign	+ 8	4	in microns
The point of binding (vertical)	+ 12	4	in microns
The point of binding (horizontal)	+ 16	4	in microns
Description for the color of the masks	+ 20	132 x N	N – number of colors
The color of the mask	+ 0	4	RGB
The mask for side of the sign	+ 4	128	bits per pixel
Total (bytes): 20 + 132 * N			

CHANGE LOG SHEET

Changes	*Numbers of sheets (pages)*				*All sheets (pages) in document.*	*Document*	*Incoming no. escort-tional document and the date*	*Signature*	*Date*
	changed	*replaces*	*new*	*cancelled*					